# GUIDE TO USING THE MONTANA DEPARTMENT OF AGRICULTURE CROP & ROTATION MODELING SPREADSHEET

Developed by: Chad Lee, Montana Department of Agriculture
February 2010

## Disclaimer:

The Montana Department of Agriculture and its staff are not responsible for:

- Decisions made by parties as a result of using of this spreadsheet or the outcome of those decisions,
- errors within the spreadsheet,
- the reasonableness of original estimates and sample rotations contained in the spreadsheet, or
- the outcome of decisions made by parties who use the spreadsheet as a decision tool after making alterations to the spreadsheet.

The Montana Department of Agriculture provides no assurance that the crops listed in the spreadsheets can be successfully grown in all areas of Montana or elsewhere.

The Montana Department of Agriculture made considerable efforts in designing and testing the spreadsheet, and measures were taken to prevent accidental alteration of formulas. Spreadsheet users should adjust the assumptions and rotation information to be applicable to their farm and check for errors before making any decisions. Ultimately, spreadsheet users are responsible for their own decisions. Spreadsheet users should avoid changing formulas, but if it is necessary to change formulas, take extreme caution.

## Purpose

The Montana Department of Agriculture created the crop and rotation modeling spreadsheet to serve as a tool for farmers to compare the economics of different crops and rotations. The spreadsheet allows users to design and compare up to eight rotations. The duration of the rotations can be up to 15 years long. For each crop/year, the user selects field operations to be performed. Up to 15 field operations can be entered for each crop/year. Selected field operations are used to calculate fuel and lubrication costs and to determine time/labor requirements for comparison and planning purposes. Spreadsheet users can use this information to consider the impacts of operations on moisture and to consider equipment needs as it pertains to the timing and synchronization of field operations.

An effort was made to develop reasonable estimates for the 2010 crop year (as of February 2010). Many of these estimates came from projections made by North Dakota State University for Northwestern North Dakota. The default yield assumptions for dryland production are based on averages from region-wide average yields for the 2004 – 2008 period in the USDA National Agriculture Statistics Service "North Central Montana Region" (Glacier, Toole, Liberty, Hill, Blaine, Phillips, Pondera, Teton, and Chouteau counties). Default yield assumptions for irrigated production are based on typical or estimated yields for irrigated cropland in southern Teton County (near Fairfield). Users can *(and should)* change these assumptions and estimates to make the spreadsheet calculations applicable to their farm and growing conditions and to reflect their expectations for future years.

**General Instructions:**

When using the spreadsheet, only modify or enter information in cells with a yellow background in the following worksheets: "Assumptions" and "Rotation 1" through "Rotation 8".

Information has already been entered in the yellow spreadsheet cells based on crop and input price levels projected for 2010. The information entered is derived from a number of sources *(See Documentation of Original Estimates Entered in Assumptions Worksheet)*. This information can *(and should)* be changed to match the production history and conditions of the farm being evaluated. Spreadsheet users should consider whether the default values reflect their expectations for the future.

It is recommended that users work through the spreadsheet in the order of the worksheets.

- The Assumptions Worksheet is a centralized location where assumptions for price, yield, and costs are entered for crops on a per-acre basis.
- The Rotation Worksheets are where the spreadsheet user designs individual rotations.
    - Information can be entered for up to eight rotations.
    - When a crop is selected for a year in the rotation, the spreadsheet uses information from the Assumptions Worksheet to calculate revenue and expenses.
    - The Rotation Worksheets are designed with some flexibility to allow spreadsheet users to add some expenses that may be specific to the farm, crop, or field for each individual year in the rotation. For example, if raising a particular crop requires the farm to rent an implement or hire a custom operator to complete a field operation, the cost can be entered on a $/acre basis.
    - The Rotation Worksheets also allow spreadsheet users to specify the field operations that will be performed in individual years. The spreadsheet uses this information to calculate the fuel cost and direct labor requirements for field work (hours/acre).
    - The charts in the spreadsheet display and compare the results of calculations made in each Rotation Worksheet.

***Yellow Spreadsheet Cells***

Information should be entered or changed only in spreadsheet cells with a yellow background. The yellow spreadsheet cells are for variables. The spreadsheet performs calculations in other cells, based on the entries in the yellow cells. Altering cells with a white background will change formulas, which will likely cause calculations to be in error, significantly impacting analysis results.

Many of the spreadsheet cells that contain formulas have a white background and are "locked". Additionally, some cells and worksheets are hidden to help prevent accidental changes to formulas and to avoid confusing spreadsheet users. If the user finds it necessary to change or unhide cells, the individual sheet must be unlocked using the following menu sequence: Tools – Protection – Unprotect Sheet – password = "password". To look for hidden cells, look at the row number for gaps, highlight the rows on either side of the gap, right click, and choose Unhide. To look for hidden sheets: Format – Sheets – Unhide – select sheet to unhide.

***Drop-down Boxes***

Drop-down boxes are used to restrict the entries that can be made in the Rotation Worksheets (Rotation 1 – Rotation 8). Drop-down boxes are also used in the Rotation Worksheets to restrict:

- selection of crops for each year in the rotation
- selection of field operations for each year in the rotation

All drop-down boxes have the option to select a blank entry if no selection is desired; the only way to select a blank entry is by using the drop-down box. If the Rotation Worksheet has information entered into more years than is desired for a rotation, blank entries should be selected for that year's crop and field operations.

***Navigating the Spreadsheet:***

<table>
<tr><th>WORKSHEETS (in order)</th><th>EXPLANATION & INSTRUCTIONS</th></tr>
<tr><td>Disclaimer</td><td>Liability disclaimer</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Assumptions</td><td>The majority of adjustable spreadsheet variables are located in the Assumptions Worksheet (yellow spreadsheet cells).<br><br>Adjustable variables exist for crop, commodity market price, yield, seed cost, herbicide cost, fungicide cost, insecticide cost, crop insurance cost, fertilizer application rate and cost, fuel and lubrication cost, field operation fuel consumption, off-farm commodity trucking cost, irrigation costs, operating interest cost, net present value discount rate, and machinery capacity (for field operation time requirements).</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Rotation 1<br>Rotation 2<br>Rotation 3<br>Rotation 4<br>Rotation 5<br>Rotation 6<br>Rotation 7<br>Rotation 8</td><td>These worksheets allow users to design up to eight rotations.<br><br>In each worksheet:<br>• Use drop-down boxes to select the crop to be grown each year to establish the sequence of the rotation (up to 15 years in length).<br>o Select blank entries for years not under consideration.<br>o Enter information so that cycle of a rotation is complete. (For example, if the rotation is winter wheat – chem. fallow, the following should be entered: Yr1 – Winter Wheat, Yr2 – Chem Fallow).<br>• Use drop-down boxes to select the field operations to be performed for each year in the rotation (up to 15 operations per crop/year).<br>o Select blank entries for years not under consideration.<br>• The yield adjustment factor increases or decreases the yield of a particular year (relative to the yield entered in the Assumptions page for a given crop) to allow spreadsheet users to make adjustments to reflect rotational benefits that may be achieved by incorporating pulse crops or oilseed crops into a rotation. A yield adjustment factor of 100% results in no change, 200% doubles the yield, 50% reduces the yield by half.<br>• Adjustable variables Land Rent, Custom Hire (Contracted Field Operations), Machine Rent, Direct Labor, and Other Direct Costs allow spreadsheet users to enter additional direct costs that may apply to the crop/year.<br>o For purposes of comparison, these costs only matter if there is a difference in these costs between crops, years, or rotations.</td></tr>
</table>

*Navigating the Spreadsheet:*

<table>
<tr><th>WORKSHEETS (in order)</th><th>EXPLANATION & INSTRUCTIONS</th></tr>
<tr><td></td><td></td></tr>
<tr><td>Rotation 1<br>Rotation 2<br>Rotation 3<br>Rotation 4<br>Rotation 5<br>Rotation 6<br>Rotation 7<br>Rotation 8</td><td>(Continued)
<ul>
<li>The spreadsheet calculates a legume crop fertilizer credit in the year peas or lentils are grown, when peas are plowed down, and in the last year of an alfalfa stand. The amount of credit is based on the value of the nitrogen fixed. The legume crop fertilizer credit appears in the spreadsheet as a “negative expense” (income). As such, this is a non-cash benefit that is not realized in the year presented, but is attributed to the legume crop.
<ul><li>If spreadsheet users want this credit to be $0, the credit amounts (lbs/acre) should be set to zero in the Assumptions Worksheet.</li></ul></li>
<li>The yield, commodity price, direct costs, and return (after direct costs) are shown for each crop/year in the rotation.</li>
<li>Direct labor requirements for field operations (hours/acre) for each crop/year.</li>
</ul>
Rotation Summary Calculation:
<ul><li>Average annual return after direct costs for the rotation.</li></ul></td></tr>
<tr><td></td><td></td></tr>
<tr><td>Rotation Summary</td><td><ul>
<li>Summarizes the average annual returns (after direct costs) for rotations.</li>
<li>Lists the crop sequence designed for each rotation.</li>
<li>Information presented in crop comparison and rotation comparison charts is gathered from the Rotation Summary worksheet.
<ul><li>If users want to change chart axis labels, these changes have to be made in the Rotation Summary Worksheet.</li></ul></li>
</ul></td></tr>
<tr><td></td><td></td></tr>
<tr><td>Crop Comparison (Chart)</td><td><ul>
<li>Compares return after direct costs in spreadsheets where Rotation 7 is set to compare all crops.</li>
<li>Not available on NC_MT_2010_Dryland_Additional_Rotations.xls</li>
</ul></td></tr>
<tr><td></td><td></td></tr>
<tr><td>Rotation Comparison (Chart)</td><td><ul>
<li>Compares average annual returns of rotations. X-axis labels are abbreviations of rotations pre-entered into the spreadsheet. These labels are set in the Rotation Summary page.
<ul><li>If crop sequences are changed, the labels on the Rotation Summary page need to be updated.</li></ul></li>
</ul></td></tr>
<tr><td></td><td></td></tr>
<tr><td>Rotation Comparison All (Chart)</td><td><ul>
<li>Compares average annual returns of rotations. Labels are set to “Rotation 1” – “Rotation 8”.</li>
<li>In the spreadsheets set up to compare crops (Rotation 7 and Rotation 8), Rotation 7 and Rotation 8 are not really rotations.</li>
</ul></td></tr>
<tr><td></td><td></td></tr>
<tr><td>Rotation Charts (1-4 & 5-8)</td><td><ul>
<li>Provide graphs for each rotation showing the year-to-year return after direct costs.</li>
<li>Shows average annual return after direct costs for each rotation</li>
</ul></td></tr>
</table>

***Key Comparisons***

- Crop Comparisons: In spreadsheets that compare the economics of different crops, the comparison is the "return after direct costs" per acre. Return after direct costs is a measure that does not include all sources of income or all costs, but instead attempts to narrow and simplify comparisons to relevant differences between crops and rotations.
    - This comparison does not take into account other farm income streams such as government payment revenue, crop insurance revenue, custom farming revenue, or land easement rents and royalties (for conservation, wind energy, or oil and gas production).
        - It is acknowledged that revenue from multiperil crop insurance and government payment programs (such as the ACRE program) may be important considerations in crop and rotation selection that are not taken into account with this decision tool.
    - This comparison also does not take into account fixed costs (such as labor and depreciation), land costs (for which there are no differences between crops or rotations in the case of land that is owned or cash lease land), or certain indirect overhead costs such as repairs or liability insurance that may be difficult to allocate to a particular field or crop. Many of these costs will be incurred regardless of and independent of crop and rotation selection and therefore are not relevant to the comparison.
        - Flexibility exists within the spreadsheet to allow some of these types of costs to be added, if indeed these costs can be accurately allocated or if there will be additional costs identifiable to a particular crop or rotation.
- Rotation Comparisons: Rotations are compared by the following measure: average annual return after direct costs per acre (for the duration of the rotation).

## **Documentation of Original Estimates Entered in Assumptions Worksheet:**

Many of the "default" estimates entered into the Assumptions Worksheet of the dryland versions of the spreadsheet are "localized" for the north central Montana region (Glacier, Toole, Liberty, Hill, Blaine, Phillips, Pondera, Teton, and Chouteau counties). Default estimates entered into the Assumptions Worksheet of the irrigated version of the spreadsheet are localized for southern Teton County (Fairfield area). Assumption estimates may be applicable for irrigated production areas of northern Cascade County, northern Teton County, Pondera County, and Glacier County. Users should adjust these estimates to reflect their own conditions, circumstances, and expectations of the future.

***Source of Information for Crop Yields:***

- The yields entered into dryland versions of the spreadsheet are region-wide average yields (for the 2004 – 2008 period) in the USDA National Agriculture Statistics Service "North Central Montana Region" (Glacier, Toole, Liberty, Hill, Blaine, Phillips, Pondera, Teton, and Chouteau counties). Default yield assumptions for irrigated production are based on typical or estimated yields for irrigated cropland in southern Teton County.
    - For the dryland versions of the spreadsheet, default yield data entered in the Assumptions is derived from non-irrigated production statistics (to the extent possible), rather than from overall average county yields. For major cereal crops,

NASS publishes more detailed county-wide statistics for non-irrigated acreages: non-irrigated fields *following summer fallow* and non-irrigated fields *under continuous crop management*. The Assumptions Worksheet utilizes this detailed information for cereal grain yield assumptions.

  - NASS did not publish yield data (or necessarily collect data) on every crop and related management practice for every county, every single year. This is a function of both farmers' planting decisions and NASS's statistics collection decisions and information disclosure policy.

***Crop Prices:***

- The crop prices entered into the spreadsheet are based on crop prices projected by the North Dakota State University Extension Service for Northwest North Dakota for 2010 (http://www.ag.ndsu.edu/pubs/agecon/ecguides/nw2010.pdf), with some modifications for lentil and chickpea prices based on industry price signals communicated in February 2010 (www.statpub.com) reports and conversations with buyers and processors. The price used for peas are for food grade green peas, which are priced at a premium to food grade yellow peas. The camelina price is based on contracts available in January 2010 from Sustainable Oils for 2010 production. Alfalfa prices are based upon Montana Department of Agriculture staff estimates. Many forces are at work that will impact commodity prices in 2010, a wide range of commodity prices are possible and volatility may continue, particularly for alternative crops. The Assumption Worksheet's prices can be changed to what the user believes to be appropriate for the time horizon under consideration.
- The crop prices used are based on the most common price unit used in trading the commodity ($/bushel, $/lb, $/ton). Barley is traded in bushels and hundredweight, which causes confusion. The spreadsheet bases the barley price on $/bushel. To convert a $/hundredweight price to $/bushel (for barley), multiply the $/hundredweight price by 0.48. Commodity test weights are presented in the section of cost assumptions that pertains to seed cost (Row 21 in the Assumptions Worksheet).

***Seed, Herbicide, Fungicide, and Insecticide:***

- The seed costs entered into the spreadsheet (on a $/acre basis) were derived using typical seeding rates and from information presented in *Projected 2010 Crop Budgets North West North Dakota*, prepared by North Dakota State University Extension Service. The price of seed for peas was increased to reflect the higher price of proprietary varieties that may be used for food grade green pea production. www.ag.ndsu.edu/pubs/agecon/ecguides/nw2010.pdf
  - Users can (and should) adjust the seed price and seeding rates to levels they feel are appropriate.
- For the dryland spreadsheets, the costs entered into the spreadsheet (on a $/acre basis) for herbicide, fungicide and insecticide are derived from estimates made in Projected 2010 Crop Budgets North West North Dakota, prepared by North Dakota State University Extension Service. Similar current information is not published for Montana. It seems reasonable to use the cost projections for northwest North Dakota as a basis for direct costs in Montana because the estimates/projections are current, are made by qualified professionals, and are for similar farming practices and conditions as occur in Montana.

These projections may be less reliable for farms that are distant from northwest North Dakota and have different growing conditions. Herbicide, fungicide, and insecticide costs for the irrigated spreadsheet are based on the input of farmers from southern Teton County.

  - Herbicide costs may vary significantly from the estimates provided. On an individual farm, the cost of herbicides on a per-acre-basis can vary widely between fields depending on conditions and herbicide selection.
  - Except of safflower and chickpeas, fungicide costs for Montana crops are assumed to be zero, which is different than the northwest North Dakota projections.
- Spreadsheet input cells are provided for users to enter the number of chem fallow herbicide applications required and the chemical cost per acre of each application.

***Crop Insurance***

- For the dryland spreadsheets, crop insurance costs are derived from estimates made in Projected 2010 Crop Budgets North West North Dakota. For the irrigated spreadsheet, 2010 premiums are based on 2009 premiums per acre for Teton County, factored by changes in crop prices between 2009 and 2010 projections. 2009 crop insurance premium information is available from USDA Risk Management Agency (http://www3.rma.usda.gov/apps/sob/stateCountyCrop.cfm ).
  - Crop insurance costs may vary significantly from the estimates provided.
  - In some counties in Montana, it may not be possible to insure all of the crops listed in the spreadsheet. Spreadsheet users can contact their crop insurance agent or enter cost estimates ($/acre) they believe to be appropriate for their production history and desired level of coverage.
  - The default crop insurance cost does not include hail insurance, the cost of which varies with the location of the farm, but not with the crop selection.
- The spreadsheet does not provide a means to model the revenue that crop insurance provides when a loss occurs. Because of this, the spreadsheet reflects an implied assumption that a loss of crop revenue will be equally offset by insurance revenue. In reality, crop insurance does not provide complete coverage for losses of crop revenue.

***Fertilizer Costs:***

- Nitrogen application rates are based on recommendations made in *Fertilizer Guidelines for Montana Crops*, published by the Montana State University Extension Service in 2005 for the average yields used to calculate crop revenue.
- Nutrient uptake of phosphorus, potassium, and sulfur was calculated for each crop based on the same yields and are based on nutrient uptake estimates made in *Fertilizer Guidelines for Montana Crops*.
- The fertilizer application rate is calculated by multiplying the nutrient uptake (utilization) at average yields by a factor "Application - % of Replacement Requirement" that allows users to increase or decrease nutrient application based on soil tests or other fertilizer application strategies.
- In the Assumptions Worksheet, the default cost of individual fertilizer components ($/lb of nutrient) for Nitrogen, Phosphorus, Potassium, and Sulfur are based on Fall 2009 fertilizer prices reported by the Montana Department of Agriculture Fertilizer Program.

The price of many types of fertilizers decreased significantly in Fall 2009 relative to Spring 2009 or Fall 2008. However, the cost of fertilizers containing phosphorus and potash continue to be significantly higher than historic levels.

  - Nitrogen prices have dropped significantly due to lower natural gas prices driven by slower economic activity and major new natural gas fields coming into production. Because of trends for increasing global energy consumption, wide concern over greenhouse gas emissions, the convenience and cost-effectiveness of using natural gas for electricity generation to "firm" wind energy, and the perception that natural gas is a "clean" fossil fuel, it seems reasonable to assume that demand for natural gas will remain strong. Strong natural gas demand will likely prevent nitrogen fertilizer prices from decreasing much lower (*than current levels*) and will quietly likely lead to higher nitrogen fertilizer prices in future years.

- Nitrogen fertilizer requirements (and cost) for crops following alfalfa and pulse crops will be lower in theory. The spreadsheet takes nitrogen fixing into account by reducing the direct cost of growing alfalfa and pulse crops by the estimated value of the fixed nitrogen. While any actual cost reduction occurs after pulse crop or alfalfa production, it seems appropriate to attribute the economic benefit to the pulse crops or alfalfa.
  - Nitrogen credits are estimated for raising pulse crops for grain (10 lbs N/acre), for pulse plowdown crops (20 lbs N/acre), and for alfalfa (100 lbs N/acre).
  - The calculated value of the fixed nitrogen is based on the estimated nitrogen credits and the cost of nitrogen used in fertilizer cost calculations.

***Fuel & Lubrication Costs:***

- Direct fuel cost estimates are based on the fuel consumption of field operations selected for each crop/year multiplied by the estimated dyed diesel price. The field operations for each crop/year are selected in the Rotation Worksheets.
  - The source of information for fuel consumption of individual field operations is a study published by the Colorado State University Extension Service in 2007, titled *Estimating Farm Fuel Requirements* (http://www.ext.colostate.edu/PUBS/FARMMGT/05006.html ). Users can change fuel consumption rates to match their experience.
    - Some modifications of fuel consumption rates were made in response to farmer input.
  - Estimates were made for the fuel consumption of the following field operations: broadcasting seed or fertilizer, rolling, and canola kinking.
- Fuel costs are based on dyed diesel only, using North Dakota State University Extension Service's estimate for 2010.
- Lubrication costs are estimated to be 15% of fuel costs. This is a percentage used in several other farm production economic analyses. Spreadsheet users can the change lubrication cost estimate factor.

***Off-Farm Trucking to Market:***

- The cost of off-farm trucking to market is based on an estimated trucking rate ($/loaded mile), weight of crop to be hauled from the farm to market (per acre of production), weight of commodity that can be hauled in a semi trailer (lbs/load), and estimated distance from farm to market.

    - The weight of crop to be hauled (per acre) is based on the yields used to calculate revenue.
    - The weight of the grain that can be hauled in a semi trailer with a pup trailer is presumed to be 69,000 lbs, except for safflower (43,700 lbs – due to a lighter test weight than the other crops). For single trailers, the load may weigh approximately 48,000 lbs, except for safflower (30,400 lbs).
    - The default load for alfalfa is set to 40,000 lbs/load for local hauls on a semi trailer. For long-distance hauls on double trailers, the load may weigh 60,000 lbs. These load estimates are for square bales.
    - The Assumptions Worksheet allows users to enter different distances to market for each crop. Spreadsheet users should update the assumptions to the situation for their operation. Actual distances to market will depend on the proximity of the farm operation to grain buyers of a given commodity.
- The cost of off-farm trucking is also calculated in units of $/bushel and $/ton (alfalfa).
- With fuel and trucking costs in flux, spreadsheet users should adjust the cost per loaded mile estimate to reflect their own projections for future trucking costs. Backhauls may provide an opportunity to reduce trucking costs.

***Operating Interest***

- Operating interest is calculated based on the sum of all other direct costs multiplied by an annual interest rate and divided by the fraction of a year that interest accrues.
    - The original estimates use an APR of 8.5%, with interest accruing for nine months. Spreadsheet users should adjust the APR and months of accruing interest to reflect actual conditions for the operation.
    - If an operation is in a strong cash position and does not use operating loans, the APR should be adjusted to match the interest rate the operation receives from farm savings accounts that are used to finance operations. In this situation, the number of months of accruing interest should match the operating cycle (average period from expenditure of operating cash to receiving cash from sale of crop commodities).

***Field Operations Time/Labor Requirements***

- The Rotation Worksheets calculate the total hours of field operations (direct labor requirements) per acre for each crop/year in the rotation. The calculations depend on the field operations selected for each crop/year in the Rotation Worksheets and on equipment productivity information entered into the Assumptions Worksheet.
    - In the Assumptions Worksheet, the required hours per acre for each field operation is calculated based on the implement width, operating speed, and operating efficiency. The Assumptions Worksheet also calculates the acres/hr productivity rate for each field operation.
    - The operating speeds and efficiencies used in the initial assumptions are based on information provided in the *Enterprise Crop Budget Generator* spreadsheet created by Duane Griffith of the Montana State University Extension Service. (http://www.montana.edu/wwwextec/software/enterprisebudgetor.xls )

    - Spreadsheet users can (and should) adjust implement operating width, speed, and operating efficiency to match the farm operation being analyzed.
    - Harvesting speed of alternative crops will likely be slower than cereal grain crops. However, the spreadsheets do not account for the potential difference in harvesting speed.
- Spreadsheet users can use the field operations calculations to evaluate time requirements for different crops and rotations. These calculations may lead users to consider equipment needs, the possible need to utilize custom farming services, and consider the timing and synchronization of field operations. In appropriate situations, the calculations can potentially be used to compare direct labor costs between alternatives.

**Discussion on Approach of Economic Comparison: *Return After Direct Costs (Per Acre)*:**
The following paragraphs explain concepts that are the basis for the design of the spreadsheet.

Ultimately, the spreadsheet compares the Return After Direct Costs per acre in a comparison that is limited to relevant costs and relevant revenues of different crops, rotations, and farming practices. This approach makes comparisons based on the differences between the alternatives (relevant costs and relevant revenues) and ignores costs and revenues that are the same regardless of the alternatives.

With its focus on Returns After Direct Costs Per Acre, it is hoped that the spreadsheet will be a user-friendly tool that can produce comparable analyses for a wide range of users. There can be great variation of indirect and fixed costs between farm operations due to differences in farm size, ownership of farmland and equipment (owned or rented), stage of land and equipment debt repayment, age of equipment, equipment replacement strategies, and labor costs (*which can be dependent upon the cost of the lifestyles maintained by farm owner-operators and the influence of off-farm income*).

Relevant comparisons can ignore fixed costs, so long as fixed costs remain the same for the alternatives being compared. In the overall farm cost structure, indirect costs tend to be fixed costs. For the individual farm, these costs do not vary with the number of acres farmed, unless major expansion or contraction occurs. Fixed costs do not vary with the alternatives being considered by the spreadsheet: crop/rotation selection. Therefore, within the constraints identified, fixed costs are not relevant to the comparison of alternatives.

Including land cost in the comparison can create problems for comparability because of the differences between cash rent, crop share rent, and the “cost” of owned land. The land cost of rented land is a direct cost, whereas the “cost” of owned land is not a direct cost. Land cost for fields rented on a crop share basis will likely vary between alternatives because the cost is based on crop revenue and shared fertilizer cost, which will vary between crops. Other relevant differences could arise if the landlord in a crop share rental arrangement places different limitations on the crop selection and rotation decision. In terms of relevancy for comparison purposes, the cost of cash-leased land and owned land should not be relevant because the costs should not vary between the alternatives.

Direct revenue varies between crop types because of the differences in crops' yield and market price. For a given crop, direct costs should not vary greatly on a per acre basis, if best practices are followed and prudent judgment is used. Direct costs will likely differ between crop types.

In traditional accounting and economics terminology, the term "variable costs" includes costs that this guide and the spreadsheet refer to as direct costs. The terminology for "variable costs" was originally derived to describe costs in a manufacturing setting. Variable costs are costs (such as the cost of raw materials) which vary with the quantity of products being manufactured. The quantity of production (*and therefore variable costs*) is within the manufacturer's control. Unlike manufacturers that try to match production with market demand, farms seek to maximize production at the field level to the point of diminishing returns. The quantity of what is harvested on a farm (its production) tends to be much more dependent upon weather than the farm's investment in inputs (direct costs), which impact yield to varying degrees. As such, in the farm setting, what drives "variable costs" is not the quantity of commodity harvested *(which is largely beyond the farm's control)* but rather the number of acres of given crops planted *(something which the farm has control)*. This is an important difference between crop production and traditional manufacturing in the relationship between variable costs and production levels. Under the approach used in the spreadsheet, the presumption is that available acreage for a farm is fixed, with the variable factors being crop selection and rotation sequence.

Determination of Return After Direct Costs Per Acre is not a calculation of a total economic return. The calculation of total economic returns is not necessary for comparing alternatives in a short-term to mid-term time horizon. Total economic returns are important for evaluating the economic viability of a farm operation and for making strategic investment or liquidation decisions.

Comparison of the Returns After Direct Costs Per Acre examines alternatives for which operational decisions for change can be made. This analysis focuses on operational decisions (crop selection and rotation design) with the assumption that this is the primary decision area for the individual farm. A major assumption for this approach is that the individual farm will not be making major changes to its fixed cost structure in the short-term to mid-term. Fixed costs generally change as the result of investment and hiring decisions. Equipment purchases or increasing hired labor to enable acreage expansion are examples of changes in fixed cost structure for farm operations. The assumption that the individual farm will not be making major changes to its fixed cost structure is reasonable in an environment where the availability of additional cropland is low and where the probability of securing additional available land is low (for many farm operations). Retirement of Montana's aging farm operators is a factor that could increase land availability. However, it is unclear whether the situation of intense competition for land will change – even as Montana's farm operators age. Montana is not shielded from outside influences such as farm consolidation driven by technology and declining commodity margins, land speculation, and trophy farm/ranch ownership.

Return After Direct Costs Per Acre ***for a given crop*** should not vary greatly between farm operations, assuming that best practices are followed and prudent judgment is used. More variation is likely to exist between farm operations' fixed costs. Both elements of cost involve strategic decisions. The strategic decisions developed around analysis of Return After Direct Costs seek economic advantage through crop rotation selection (diversification, rotational benefits, niche opportunities). The strategic decisions affecting indirect and fixed costs are focused on achieving economic advantages through efficient use of capital investment and variations in the configuration of capital investment. Both kinds of strategic considerations are important.

***Comparison of Rotations Instead of Individual Crops***

To achieve comparability, the economic performance of different rotations must be calculated on an average annual return basis. Evaluating rotations also acknowledges that there are constraints to sequences of crops. Diversification of crops within rotations may provide production and market risk diversification. Farming operations can use the spreadsheet to compare traditional rotations (such as wheat-fallow) with rotations designed to achieve higher levels of integrated pest management, rotation-driven yield enhancement, economic diversification, and fertilizer cost reduction through nitrogen fixing.

***Key concepts / Assumptions***

- *Return After Direct Costs as the appropriate measure for comparison:*
    - Crop Revenue – Direct costs = Return After Direct Costs
        - Examples of direct costs include seed, fertilizer, herbicides, insecticides, crop insurance, fuel and lubrication, trucking to market, and related operating interest.
        - Cash rent is a direct cost that is a fixed cost, as is the "cost" of owned land. Crop share rent is a direct cost that varies with yield, crop prices, and fertilizer cost share. In the default rotations, it is assumed that land cost does not vary with the alternative, or is "sunk" and therefore is not relevant to comparing alternatives.
            - The spreadsheet allows land rent to be manually entered as a direct cost for each crop/year in each rotation. It would be appropriate to include this in the analysis if the land rent varies between the crops grown. Between alternatives, a difference in land rent cost will likely exist if land is rented on a crop share basis.
    - Fixed costs are not relevant for comparison because these costs do not vary with the rotation alternatives. Fixed costs tend to be indirect. Although they could be allocated to crops within a rotation, the cost in total would not change.
        - Examples of fixed costs include equipment depreciation, professional services, and in many situations, labor.
    - This approach is appropriate for comparing the economic performance for the short-term to mid-term time horizon.
- *The individual farm using the spreadsheet is operating within a relevant range of capacity*: Equipment and labor costs tend to be fixed for a relevant range of acreage, until expansion creates a constraint that must be overcome through addition of capacity (through equipment, labor, or paying for custom field operations). The approach of using return after direct costs remains valid even if acreage increases (within the relevant range of existing capacity) because fixed costs and indirect costs remain constant.

    - The farm is adequately equipped and does not need to hire additional labor to grow any of the crops being considered.
    - If the situation exists where the cost structure of a farm has labor costs that are identifiable as direct costs (and where the direct labor cost varies with different crops) the spreadsheet allows users to manually enter those costs on a per-acre basis for each crop/year in each rotation. Similarly, if the farm has custom hire costs or machine rental costs that are identifiable as direct costs and vary with the individual crop, the spreadsheet allows those costs to be entered for each crop/year in each rotation.
- *The individual farm using the spreadsheet is a going concern*: The farm is economically viable so that it is capable of staying in business and its owners are committed to continued operations. If there is any question, a total economic return should be calculated to determining whether the farm operation is a going concern.
- *Sunk costs*: Costs incurred for past decisions "are sunk" and should not have undue influence future decisions. What is done is done; planning for the future should focus on what provides the best returns in the future. Many indirect costs or fixed costs are sunk costs.
- *Assumption that government payments are not significantly different between options:* Government payments are omitted from this analysis since government payments tend to be somewhat fixed regardless of planting decision (with exception of LDP payments, and now ACRE) and have been declining over the last two decades (*and therefore are of less significance at the "per-acre" level, with the acknowledgement of their importance at the farm-level in contribution to net income in an environment of declining margins and increasingly larger farms*). It is difficult to evaluate the role government payments will play (if any) in the comparative economics of different crops and rotations.
    - In the short term, the ACRE program appears capable of influencing crop selection decisions (*probably to discourage farmers from growing alternative crops*).
    - On the other hand, the Conservation Security Program provides the opportunity for incentive payments for farms incorporating diverse rotations.
- *Because crop insurance revenue is not considered, it is assumed that crop insurance proceeds equal the value of the crop loss.* In reality, because crop insurance only provides a certain percentage of coverage, crop insurance settlements do not replace the full amount of income lost by impaired yields. County yields may vary significantly (between each other) for alternative crops, which may impact the level of protection available for alternative crops. Multiperil crop insurance policies may not be in place for some alternative crops, which may mean that coverage is not available or that individual policies must be written.
- *Lack of consideration for variability (of numerous factors: yields, commodity prices, direct costs).* The spreadsheet models the economic performance of crops and crop rotations with single-value assumptions. The default values entered into the Assumptions Worksheet are based on averages, information for given points in time, standard commodity quality, and rough estimates for the future that are applied throughout the time horizon being considered. In reality, the numbers entered for each assumption have a range of possible values, with different probabilities of occurrence. Variables (such as yield) have different coefficients of variability for different crops and crop sequences.

- An ideal economic model would account for variability and probability and be supported by perfect information specific to the farm being analyzed. The ideal economic model would assess risk or the impact of variability on calculated economic outcomes. Incorporating mechanisms to account for variability into the spreadsheet could add considerable complexity to the spreadsheet design, make the spreadsheet less user-friendly, and interfere with the objective of making the spreadsheet highly flexible. The spreadsheet's current design provides latitude to users to use their own judgment in developing farm-specific assumptions. It is unclear whether sufficient information is available to analyze variability on a state-wide scale, let alone *(and more importantly)* at a localized level that would be applicable to an individual farm.
- An ideal economic model would not limit the consideration of variability to commodity yields and prices. In addition to commodity yield and price, an ideal economic model would consider the variability of significant direct costs in the comparison of alternatives.
- The spreadsheet is meant to be used as a first step in the consideration of alternatives in crop rotation. Farmers constantly face changing conditions that affect numerous variables. Farmers have to reach decisions without complete information. Ultimately, farmers must utilize available information, observation, and personal experience to perform their own personal calculus *(that considers risk and variability)* to reach decisions. Experience, risk tolerance, economic situation, growing conditions, and the individual farm's agricultural capacity vary - *which is why different farms adopt different farming strategies*.
- It is expected that most farmers require alternatives crops or rotations to provide economic returns that exceed the status quo (cereal – fallow rotation) before making changes. It is assumed that in determining the minimum amount of "premium" required to stimulate change, the individual farmer applies "personal calculus" that accounts for variability and risk.
  - In other words, each individual farmer considers the following questions:
    - To what degree do I believe the numbers calculated?
    - How likely is the projected outcome?
    - How much more effort will the alternative require?
    - How will the alternative affect the rest of the operation?
    - If the alternative does not turn out, how much worse off will the farm be than if it stayed with the status quo?
    - Considering everything, is the potential economic benefit high enough to take on the risk?
- One way for spreadsheet users to examine the impact of variability is to make multiple models that show best case estimates, worst case estimates, and average/expected case estimates for the most significant variables (such as commodity price, yield, fertilizer cost, herbicide cost, and trucking cost). Making multiple models will not address the probability of outcomes, but will help estimate the potential range of outcomes.

- *The spreadsheet does not allow users to vary the prices of commodities or direct costs with time.* This limitation simplifies the spreadsheet design and improves ease of use, but requires that spreadsheet users enter what they believe will be representative prices for the timeframe under consideration. Spreadsheet users should consider this limitation in their personal calculus of variability and risk.

- It is presumptuous to consider the default values of prices and input costs entered into the spreadsheet to be representative of future prices and costs. It would seem equally presumptuous to attempt to predict future prices of commodities and direct costs on a year-by-year basis. As witnessed in 2007 and 2008, even expert industry analysts can be significantly off in predicting prices of commodities and direct costs.
  - The duration and impact of the current recession on commodity prices and direct costs in the short-term and mid-term is unknown.
  - Numerous trends will affect commodity prices, direct costs and agricultural practices in the future. Examples of these trends include: population growth, improved global standard of living, increased integration of global economies, leaner inventory management that is more susceptible to supply shortages *(and depresses prices when surpluses occur)*, increased global energy consumption, declining global oil and gas reserves, increased economic and humanitarian impact of catastrophic weather events, observed changes in the global climate that may point to changing weather patterns, potential for greenhouse gas markets and regulations to impact agriculture, increasing intensity and sophistication of agriculture in second and third world nations, declining rates of reproduction in first world countries, demographic bubbles, increased concern over food safety and nutrition, advances in biotechnology and other agricultural technologies, corporate determination to promulgate biotechnology, loss of agricultural land to nonagricultural use, conflict over natural resources, and weakening in the United States' position as the world economic leader *(which can directly impacts exchange rates and interest rates).*

## References & Resources:


Agriculture Agri-Food Canada – Pulse Outlook & Oilseeds Outlook
http://www.agr.gc.ca/mad-dam/index_e.php?s1=pubs&s2=spec&page=intro
http://www.agr.gc.ca/pol/mad-dam/index_e.php?s1=pubs&s2=go-co

Agriculture Canada and Agri-Food Canada – Market Analysis Division Publications
http://www.agr.gc.ca/pol/mad-dam/index_e.php?s1=pubs&page=desc

Alberta Weekly Grain Price Report
http://www.agric.gov.ab.ca/economic/stats/wkgrain.html
http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/sdd6248 (archive)

"*Energy Requirements for Various Tillage- Planting Systems*", and Purdue University Cooperative Extension Service Publication NCR-202-W, July 1983 http://www.ces.purdue.edu/extmedia/NCR/NCR-202-W.html

"*Enterprise Crop Budget Generator*", Montana State University Extension, last modified April 18, 2006
http://www.montana.edu/softwaredownloads/software/enterprisebudgetor.xls

"*Estimating Farm Fuel Requirements*", Colorado State University Extension Farm Management Online Fact Sheets No. 5.006, updated December 20, 2007
http://www.ext.colostate.edu/PUBS/FARMMGT/05006.html

FAO's FAOSTAT database (international production & trade):
http://faostat.fao.org/site/339/default.aspx
http://faostat.fao.org/site/567/default.aspx#ancor

Government of Saskatchewan - Agriculture Market Trends
http://www.agriculture.gov.sk.ca/MarketTrends

Intercontinental Exchange (Canola Futures) https://www.theice.com/homepage.jhtml

Montana Wheat & Barley Committee – Montana Current Prices
http://wbc.agr.mt.gov/Producers/pricing_current.html

Montana Wheat & Barley Committee – Montana Historical Prices
http://wbc.agr.mt.gov/Producers/pricing_historical_mt.html

North Dakota State University Extension Service – Farm Management Planning Guides
http://www.ag.ndsu.edu/pubs/ecguides.html (2010 & most recent regional Crop Budgets)
http://www.ag.ndsu.nodak.edu/aginfo/farmmgmt/cropbudget.htm (archive Crop Budgets)

North Dakota State University, "Pulse Crop Marketing Guide", August 2006
www.ag.ndsu.edu/pubs/agecon/market/ec1277.pdf

Statpub.com Cash Prices http://www.statpub.com/stat/cash-mkt.html

Statpub.com Spot Market Specialty Crop Grower Bids http://www.statpub.com/stat/prices/spotbid.html

USDA Agriculture Marketing Service Market News and Transportation Data
http://www.ams.usda.gov/AMSv1.0/ams.fetchTemplateData.do?template=TemplateB&navID=MarketNewsAndTransportationData&leftNav=MarketNewsAndTransportationData&page=LSMarketNewsPage

> USDA Agriculture Marketing Service Market News and Transportation Data - State Hay Archives
> http://www.ams.usda.gov/AMSv1.0/ams.fetchTemplateData.do?template=TemplateW&navID=RN2HayL1&rightNav1=RN2HayL1&topNav=&leftNav=MarketNewsAndTransportationData&page=SearchHayReports&resultType=&acct=lsmn
>
> Weekly National Bean, Pea & Lentil Market Review
> http://www.ams.usda.gov/mnreports/gl_gr851.txt
>
> Dry Edible Bean Daily Grower Bids http://www.ams.usda.gov/mnreports/gl_gr510.txt
>
> Bean Market News Bean Market News (Tue) – pdf
>
> Annual Bean Market News Review Annual Bean Market News Review - pdf
>
> Kansas City Commodity Invitation of Bids
> Kansas City Commodity – Invitation of Bids - pdf
>
> Kansas City Commodity Awarded Bids Kansas City Commodity-Awarded Bids - pdf

USDA National Agriculture Statistics Service - Montana County Yield Statistics
http://www.nass.usda.gov/Statistics_by_State/Montana/index.asp (MT County Level Data – Crops)

USDA National Agriculture Statistics Service - Montana Prices Received, Monthly & Marketing Year Averages and Other Economic Data
http://www.nass.usda.gov/Statistics_by_State/Montana/Publications/econtoc.htm

USDA Risk Management Agency – Federal Crop Insurance Corporation
Summary of Business Database http://www3.rma.usda.gov/apps/sob/stateCountyCrop.cfm

## Alternative Crop Industry Organizations:

| | |
|---|---|
| Northern Pulse Growers Association | http://www.northernpulse.com/ |
| U.S. Dry Pea & Lentil Council | http://www.pea-lentil.com/ |
| Saskatchewan Pulse Growers | http://www.saskpulse.com/ |
| Alberta Pulse Growers | http://www.pulse.ab.ca/ |
| Pulse Canada | http://www.pulsecanada.com/ |
| Canola Council | http://www.canola-council.org/ |
| Northern Canola Growers Association | http://www.northerncanola.com/ |
| Saskatchewan Mustard Development Commission | http://www.saskmustard.ca/grower/index.html |
| Flax Council of Canada | http://www.flaxcouncil.ca/english/index.jsp |
| Ameriflax | http://www.ameriflax.com/ |

## Crop & Crop Rotation References & Resources:

**Alfalfa:**
"*Alfalfa*", August 1998, Kansas Rural Center Sustainable Agriculture Management Guide
http://www.kansasruralcenter.org/publications/alfalfa.pdf

"*Establishing a Successful Alfalfa Crop*", MontGuide MT 200504 AG, issued May 2005, Montana State University Extension Service
http://msuextension.org/publications/AgandNaturalResources/MT200504AG.pdf

"*Production of Rain-Fed Alfalfa*", Montana State University Extension Service, 2007
http://ag.montana.edu/carc/extenpub/07cashproductionrain.pdf

**Camelina:**
"Camelina Production in Montana", Montana State University Extension Service: Montguide MT200701AG, revised March 2008,
http://msuextension.org/publications/AgandNaturalResources/MT200701Ag.pdf

**Canola:**
"Canola Production Field Guide", North Dakota State University Extension Service, February 2005
www.ag.ndsu.edu/pubs/plantsci/crops/a1280.pdf

North Dakota State University ProCrop Canola Menu http://www.ag.ndsu.edu/procrop/rps/index.htm

**Chickpeas:**
"Growing Chickpea in the Northern Great Plains", Montana State University Extension Service; MontGuide MT 200204 AG, issued March 2002
http://msuextension.org/publications/AgandNaturalResources/MT200204AG.pdf

"Growing Chickpeas (Garbanzo Beans) in Montana", Montana State University Integrated Pest Management Center, Last Update: November 16, 2001
http://ipm.montana.edu/MPIN/Cropfiles/ChickGarb.htm

Saskatchewan Pulse Production Manual – Chickpea www.saskpulse.com/media/pdfs/ppm-chickpea.pdf

Alberta Agriculture, Food and Rural Development; "Pulse Crops In Alberta", 1999. ($35)
order from: http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex17

**Flax:**
"*Flaxseed Production in Montana*", Montana State University Integrated Pest Management Center / USDA Pest Management Centers / NSF Center for Integrated Pest Management
http://ipm.montana.edu/MPIN/Cropfiles/flaxseed.htm

"Oilseed Flax: A Montana Specialty Crop", Montana State University Extension Service, MontGuide MT 8907: http://cropandsoil.oregonstate.edu/bioenergy/sites/default/files/FlaxOilseed-A-Montana-Specialty-Crop.pdf

North Dakota State University ProCrop Flax Menu http://www.ag.ndsu.edu/procrop/flx/index.htm

**Lentils:**

"*Growing Lentils in Montana*", MontGuide MT 199615 AG, issued June 2001, Montana State University Extension Service http://msuextension.org/publications/AgandNaturalResources/MT199615AG.pdf

"*Lentil Production in Montana*" Last Update: September 13, 2001, Montana State University Integrated Pest Management Center / USDA Pest Management Centers / NSF Center for Integrated Pest Management http://ipm.montana.edu/MPIN/Cropfiles/Lentil.htm

North Dakota State University ProCrop Lentil Menu
http://www.ag.ndsu.edu/procrop/lnt/index.htm

Saskatchewan Pulse Production Manual – Lentil www.saskpulse.com/media/pdfs/ppm-lentil.pdf

Alberta Agriculture, Food and Rural Development; "Pulse Crops In Alberta", 1999. ($35)
order from: http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex17

**Mustard:**

"*Crop Profile for Mustard in Montana*", Prepared Jan., 2002 Montana State University Integrated Pest Management Center / USDA Pest Management Centers / NSF Center for Integrated Pest Management http://www.ipmcenters.org/CropProfiles/docs/MTmustard.html

"Tame Mustard Production", Revised June 2007, North Dakota State University, Publication A-935
http://www.ag.ndsu.edu/pubs/plantsci/crops/a935w.htm

North Dakota State University ProCrop Mustard Menu
http://www.ag.ndsu.edu/procrop/mst/index.htm

"Growing Mustard" Saskatchewan Mustard Development Commission (set of mustard growing and harvesting documents) http://www.saskmustard.ca/grower/growing/index.html

"Mustard Production & Management", Manitoba Agriculture, Food and Rural Initiatives (online mustard production practices information and links)
http://www.gov.mb.ca/agriculture/crops/specialcrops/big01s01.html#field

**Peas:**

"*Crop Profile for Dry Peas in Montana*", Prepared Feb, 2002 Montana State University Integrated Pest Management Center / USDA Pest Management Centers / NSF Center for Integrated Pest Management, http://www.ipmcenters.org/CropProfiles/docs/MTdrypea.html

"*Growing Dry Pea in Montana*", MontGuide MT 200502 AG, issued May 2005, Montana State University Extension Service
http://msuextension.org/publications/AgandNaturalResources/MT200502AG.pdf
http://www.montana.edu/wwwpb/pubs/mt200502.html

North Dakota State University ProCrop Pea Menu http://www.ag.ndsu.edu/procrop/pea/index.htm

Saskatchewan Pulse Production Manual – Field Pea www.saskpulse.com/media/pdfs/ppm-field-pea.pdf

Alberta Agriculture, Food and Rural Development; "Pulse Crops In Alberta", 1999. ($35)
order from: http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex17

**Safflower:**
"*Safflower Production*" A-870 (Revised), August 2007, North Dakota State University Extension Service
http://www.ag.ndsu.edu/pubs/plantsci/crops/a870w.htm

"*Crop Profile for Safflower Production in South Dakota*", December 2001, South Dakota State University / USDA Pest Management Centers / NSF Center for Integrated Pest Management
http://www.ipmcenters.org/cropprofiles/docs/SDsafflower.html

"*Fertilizing Safflower*", SF-727 (Revised), October 1992, North Dakota State University Extension Service http://www.ag.ndsu.edu/pubs/plantsci/soilfert/sf727w.htm

**Other Crop Production Resources:**
2008 North Dakota Weed Control Guide, W-253, January 2008
http://www.ag.ndsu.edu/weeds/w253/w253w.htm

2010 North Dakota Weed Control Guide
http://www.ndsu.edu/weeds/weed_control_guides/2010_weed_control_guide/

2010 North Dakota Fungicide Control Guide http://www.ag.ndsu.edu/extplantpath/fungicide.html

North Dakota Field Crop Insect Management Guide, December 2009
http://www.ag.ndsu.edu/pubs/plantsci/pests/e1143w1.htm
http://www.ag.ndsu.nodak.edu/aginfo/entomology/entupdates/ICG_10/ICGall_10.pdf

"*Crop Rotations for Increased Productivity*" EB-48 (Revised), January 1998, North Dakota State University Extension Service
http://www.ag.ndsu.edu/pubs/plantsci/crops/eb48-1.htm

"*Fertilizer Guidelines for Montana Crops*", Publication # EB 161, March 2005, Montana State University Extension Service http://msuextension.org/publications/AgandNaturalResources/EB0161.pdf

Montana State University Extension Service - Fertilizer Economics webpage
http://landresources.montana.edu/soilfertility/fertilizereconomics.htm

"*Integrated Strategies for Managing Agricultural Weeds*", Montguide MT 200601 AG, July 2006, Montana State University Extension Service
http://msuextension.org/publications/AgandNaturalResources/MT200601AG.pdf

"*Nitrogen Credits from Sod*", Cornell University
http://nmsp.css.cornell.edu/publications/tables/pdf/N_credits_sods.pdf

North Dakota Crop Sequence Calculator, USDA Agriculture Research Service – Mandan
http://www.ars.usda.gov/Services/docs.htm?docid=10791